The Lessons Learned From the Unique Characteristics of Small Technology-Based Firms

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[Abstract] The aim of this study is to identify how characteristics of small technology-based firms (STBFs), their unique combination of internal capabilities, structure, and processes, influence strategy formulation. Based on qualitative research using multiple case studies supported by semi-structured interviews, the study's main results indicate the founder's technical expertise shapes the business, mission, and vision. Lack of resources allows limited activities in strategy formulation with few matching capabilities analyses or benchmarking studies. STBFs favor competitive analysis almost exclusively in developing a market positioning strategy without regard for other methods.

[Keywords] Small technology-based firms; firm's characteristics; strategy formulation

The small Technology-based firms (STBF) are able to leverage and support the process of industrialization, competitive gains, and development in a country. This is due to the strong research and development efforts of these organizations, which result in innovative products and new technologies. Along with other specific characteristics, STBFs distinguish themselves from other organizations by the small size and the technology-based industry to which they belong. Over time, the technology developed by the STBF matures, reducing the competitiveness of the firm. This demands a continuous investment and focus on research and development (R&D) to search for new technologies. To avoid breaking the cycle of producing new technologies, the formulation of strategies to guide these organizations is necessary.

According to Berry (1998), the strategy formulation for STBFs is an important activity, if not fundamental, for their long term success and development. To support expansion and diversification, they must choose a growth plan that takes into account the product, market, expected firm size, know-how, and organizational structure, as chosen strategies will impact the direction and the market placement of the firm. Strategy formulation may occur through different processes, phases and activities and requires analysis of information about the environment and niche of the firm. This complex process is influenced by several factors.

The internal characteristics of the STBF, which distinguish them from other organizations, are certainly factors that influence the process of strategy formulation. Studies of STBFs tend to focus on which strategies are successful, not how the process is established and can be influenced. Therefore, this research aims to identify how STBFs' internal characteristics influence their process of strategy formulation. A better understanding of this process will contribute to the evolution of business science. To meet this goal, STBF characteristics were studied and considered in light of Almeida's (2003) Strategic Planning Model. This model was applied in the development of the mechanism for data collection in the interviews.

Literature Review

Characteristics of the Small Technology-Based Firm

According to the Brazilian National Association of Organizations that Promotes Technology-Based

Firms (ANPROTEC), the technology-based firm is "[...] an entrepreneurship that fundaments its production activity on the development of new products and processes, based on the systematic application of scientific knowledge and utilization of advanced and pioneered techniques" (2002, p. 47). The technological innovation for these firms is a strategy to create barriers to competitors and build competitive differentiation.

The inherent risk of innovation is a unique characteristic of technology-based firms. Products that generate new markets imply uncertainty, since the speed of the new technology's dissemination, the technological standards customers will adopt, and changes in customer needs are all unknown (Carvalho, Machado, Pizysieznig, & Rabechini, 2000). There are also uncertainties associated with technology performance: doubts about the workability of the new product; effect of existing technologies obsolescence; processing time of the R&D; quality and final price; and unforeseen effects of the technology. To minimize these effects, STBFs, in general, have a strong relationship with research institutions and universities to help them develop, test and validate their new products.

The characteristics of the STBFs should facilitate a more complete view of this type of organization. It is possible to summarize the characteristics listed by Pearce, Chapman, and David (1982), D'Ambroise, (1989), Gélinas and Bigras (2004) and Gupta (1988), as all point to a flexible and agile organization where the information flows and the decision-making process is fast and informal. These individualities place the STBFs with advantages in relation to other types of firms by leveraging a faster response to market demands and customer needs.

Filion (1991), Gélinas and Bigras (2004), and Winston and Heiko (1990), point to the entrepreneur as the central organization character, responsible for creating the vision and making the decisions. These functions represent power in the hands of the entrepreneur for STBFs. Furthermore, according to Santos and Pereira (1989), the STBFs use a workforce with a high level of technical, scientific and engineering expertise, which affects payrolls and results in high R&D expenses. On the other hand, according to Santos (1987), these organizations do not have financial resources available, so a financial strategy is demanded to deal with this weakness.

Other characteristics of STBFs are a lack of managerial knowledge and the difficulty in obtaining it, noted by Santos (1987) and Pereira and Sbragia (2004). This negatively impacts the managerial/strategic performance of these organizations, which, in general, focus more on the operational activities. Finally, STBFs search for new markets by adapting existing technology to new products and, in response to internal market limitations, export or internationalize their operations (Berte & Almeida, 2006). Furthermore, they seek small, specific markets by having, as a product positioning strategy, a market niche focus. According to Mendes, Mecenas, and Toledo, (2004), they are highly concentrated in four activities: medical equipment; automation and precision instruments; information technology; electronic and communication equipments; and the chemical industry.

Almeida's Strategy Formulation Process

Almeida (2003) proposed a model of the strategic planning process, which was used to frame this study. The model involves the formulation of strategies in the three initial phases of the process: orientation, diagnosis, and direction. The first phase of the model, orientation, is composed of superior directives, mission, vocation, and vision. Superior directives indicate whether the firm receives orientation from its "mother" company. Next, the mission is discussed and formulated, the identification of vocation, and the defining of an organizational vision.

The next phase is the diagnosis, which encompasses four activities: internal aspects, environment analysis, field of activity, and current strategy. During the internal aspects analysis, the critical success factors (CSF) in the firm's field of activity are identified. An analysis follows in which company performance is compared to competitors, and strengths and weaknesses are identified. A strategy to leverage the company's strengths and minimize its weaknesses can also be established in this phase. In the environment analysis, the region, sector, and organizational environment are analyzed. First, the conditions of the region where the firm is established are compared to other possible locations. Factors

for regional evaluation include such items as infra-structure and public services, fiscal/tax cost, market, labor availability, quality of life, and security. In the sector analysis, Porter's (1989) competitive advantage analysis of the industry is used to analyze the power of buyers versus suppliers, saturation levels, barriers to entry, product and service substitutes, and the level of government interference. In addition, an analysis of *complementors* was added to the model in which the basic research under development by the scientists that might impact the future product development of the STBF is considered.

Lastly, an analysis of the firm's organizational environment is completed, which involves the macro (i.e. political power, inflation, GDP growth, legislation, and future population by region, income distribution and gender), operational (i.e. competition, suppliers and direct customers) and internal environment (i.e. values and aspirations of relevant employees) of the STBF. From the collection of these variables, one can build a contextual narrative, including an analysis of the potential factors that will impact the company in the future and the identification of strategies to leverage opportunities and minimize threats.

The next step is the comparison of the firm's mission to its field of activity in order to verify their alignment. Then, new strategies are analyzed within the context of the current strategy to determine if they drive the company in a different direction, which could lead to discontinuity of firm activities and a loss of synergy. A decision can then be made regarding the implementation of the new strategies. By the end of these analyses, a summary of strategies is made in the final step, direction. Similar strategies are classified, and the complementing and diverging needs are identified. Finally, those strategies more realistic to the firm are chosen for implementation.

The Analyzed Cases: Method and Results

Method and Field Procedures

The methodology for identifying how the characteristics of the small technology-based firms influence their strategy formulation process was designed as a qualitative research based on a multiple case study approach. Six firms were chosen based on fulfillment of the following prerequisites: to be a small firm according to the Brazilian Economic and Social Development Bank (BNDES, 2002) definition (gross operational sales between USD 500,000 and USD 5,000,000); to be a technology based firm according to ANPROTEC's (2002) definition; to be legally structured as a private company; to established at a minimum of ten years to be regularly operating in the market, showing sales growth from 2000 to 2005. These requirements were necessary to identify companies with success so as to enable valid evaluation. The six firms meeting the requirements that were subsequently researched were Reason, Cebra, Reivax, Cianet, Directa, and Brasystem.

In 2006, semi-structured interviews were carried out using a questionnaire, which was conducted face-to-face with one of the main partners of each firm. The questionnaire was based on Almeida's Strategic Plan Model (2003), as previously discussed, since the model was developed for and tested in STBFs. The first part of the questionnaire was used to gather data to profile the companies studied, followed by a review of the STBF's orientation and diagnosis, including all the individual steps of these phases of Almeida's model. Content analysis was used to analyze gathered data from interviews. The profile of each company is described, followed by its strategy formulation process used according to the phases of Almeida's model (2003), including orientation and diagnosis as previously described. Furthermore, the influence of the characteristics of the STBFs on the phases of the process is also described.

Profile of the Firms

Table 1 presents a summary of the six researched companies' profiles from data gathered. The objective was to gather obtain an historical perspective of the companies and other critical data on their general characteristics, such as starting dates, market data including product lines, technological capacity, number of patents, and number of employees. The six companies at the time of the research

were 12 to 19 years old, so all are past the initial maturation period of the organization life cycle. Thus, they apparently have overcome initial difficulties and have defined and formalized norms and processes. Five of the six are already ISO certified, which supports the postulation that they have formalized processes, and three have developed a strategic plan. All STBFs started in and graduated from incubators. Reason and Cianet have gone public, and the other four are limited partnerships.

According to Santos and Pereira (1989), one of the characteristics of STBFs is the demand for major investments in R&D. On the other hand, they also lack financial resources (Santos, 1987). As a result, many of these firms opt to go public as they grow in order to increase financial capacity, as was the case of Reason and Cianet. As shown in Table 1, all the owning partners hold at least a technical degree except two, who hold business degrees. This main emphasis on technical degrees may imply that the entrepreneurs lack management skills, as suggested by Santos (1987) and Pereira and Sbragia (2004). Two companies export products, which is aligned with the characteristics of the STBFs outlined by Berte and Almeida (2006), and two have patents. Three firms developed strategic planning, and one of them planned to implement it within the year. This contradicts the characteristic presented by Gélinas and Bigras (2004) that STBFs only develop short term plans.

Table 1. ***Profile of Firms Studied***

	Reason	**Cebra**	**Reivax**	**Cianet**	**Directa**	**Brasystem**
Date of establishment	1991	1990	1987	1994	1988	1993
Start as Incubator	Yes	Yes	Yes	Yes	Yes	Yes
Legal structure	Public	Limited company	Limited company	Public	Limited company	Limited company
Experience and educational background of the partners	Two electrical engineers with work experience in energy companies. Others are not involved in management.	All electronic engineers with master's degrees. Three previously worked for competitors.	All electrical engineers with master's degrees and work experience in energy generation companies.	Two electrical engineers, one automation control and one business major. Others are not involved in management.	One electrical engineer and one business major.	System analysis.
Field of activity	Products and services to monitor and control electricity temporal sync.	Make–to-order energy sources and special static converters.	Electricity generation control equipment.	Digital data communication and broadband equipment.	Manufacturing automation.	Commercial automation.
Main product line	Oscilography, energy quality, temporal sync and information systems.	Static converters, energy sources.	Speed and tension regulators.	Ethernet and HPN lines for broadband internet.	Hardware and software to collect, analyze and control fabric production.	Fast food, supermarket, restaurant and night club managing system.
Exports	No	No	Since 1994.	Since 2003.	No	No
ISO Certification	NBR ISO 9001:2000.	NBR ISO 9001:2000.	NBR ISO 9001:2000. NBR ISO 14001.	NBR ISO 9001:2000.	NBR ISO 9001:2000.	None.
Number of employees	68	76	82	40	30	13
Patents	None.	1 national	None.	1 international	None.	None.
Strategic Planning	No	In 2005 and 2006.	In 2003.	In 2005.	To start in 2006.	No

Source: Primary data, 2006.

Orientation. The superior directives as the first activity in the orientation phase of the strategy formulation process by Almeida (2003) propose that the business units, subsidiaries or departments follow strategic orientations as defined by their superior units – corporate orientations. The research revealed that none of the six STBFs have subsidiaries; as a result there is no strategic orientation to be followed. The typically small size of the STBF influences this phase of Almeida's model in that, generally, small organizations do not have affiliates or subsidiaries. This fact may facilitate the strategy formulation process at STBFs, since they need not to be concerned about strategic directives coming from other business units.

In terms of the departments following the strategic orientations defined by the top management of the company, it was found that certain characteristics of the STBFs positively influence this activity and facilitate the process. First, the STBFs researched each have three to five managers and four to five hierarchical levels, confirming the STBF characteristics of smaller number of hierarchy levels and leaner organizational structures described by Pearce II, Chapman and David (1982), D'Ambroise (1989) and Gupta (1988).

In departmental organization structures with low complexity levels, the communication process between employees is facilitated, which agrees with the communication of the strategic orientations in a firm. Second, in all case studies, the partners participated in all decisions regarding the process of strategy formulation. This is supported by Winston and Heiko (1990) and Gélinas and Bigras (2004), who postulate that the entrepreneur is the one who makes the decisions in a small company. Moreover, these partners likely exercise presidential or management level jobs and are, thus, responsible for spreading the strategic decisions to their departments. Since those elaborating the strategies are the same as those coordinating their execution, there is no difficulty in following the strategic orientations, and it is easy to execute and work according to the superior directives.

The other activities in the strategy formulation process outlined by Almeida (2003) in the orientation phase are the mission and vision elaboration, and the vocation identification of the entrepreneurs or partners. These are all somewhat intertwined in the STBFs researched. Of the six companies studied, one has no mission or vision formalized. In the other five STBFs, the process of elaborating the mission and vision was supported by external consultants. According to the interviewees, this occurred due to the lack of expertise of the partners in the strategy field. This fact upholds Pereira and Sbragia's (2004) statement that entrepreneurs of STBFs lack management knowledge, in this case in the specific area of strategy.

On the other hand, one of the characteristics of the entrepreneurs of technology based firms is their strong technical background due to the need for scientific knowledge in developing innovative products (ANPROTEC, 2002; Pereira and Sbragia, 2004). Their technical background may be merged with the vocation of the entrepreneur and the firm, making it a determinant for the definition of the mission and vision and for the delimitation of the firm's activity field. In other words, the entrepreneurs choose a field of activity based on the knowledge they have in the technology they are able to develop. As shown in Table 1, there is a high correlation between the field of activity of the firms and the academic background of their entrepreneurs.

However, to be successful, the entrepreneurs of technology based firms must also consider the market. Half the STBFs studied redefined their field of activity in their initial years of existence in order to adapt them to market needs, enabling sales growth. These firms initially defined their field and products based on the technology they developed with no regard for market needs. As Leite (2002) noted, STBFs tend to create a "technologic push" rather than a "demand pull." Consequentially, these firms were not successful in reaching the market, forcing a redefinition of their field of activity. The remaining companies studied were close to the market since beginning operations and, hence, needed no changes to the field of activity or mission.

Filion (1991) stated that the entrepreneur is the central figure that creates the vision of the company. This was evident in the STBFs studied, since in all of the firms, the partners effectively participated in its definition. As a result, they brought their personal vision, discussing their desires for

the future of their companies and identifying challenges to be faced.

Diagnosis. The diagnosis phase in Almeida's model (2003) considers the activities of internal aspects, environmental analysis, field of activity, and current strategy. In the internal aspects activity, the first step is the identification of the CSFs. Companies must identify what the customer perceives as indispensable in the product, then compare product performance to competitors' in order to identify strengths and weaknesses. The STBFs studied have invested in the relationship with customers to help identify internal aspects. Each has one partner responsible for direct customer contact. According to Rothwell and Zegveld (1978), STBFs are able to have a close relationship with customers, enabling them to better understand customer needs. Among actions to obtain information on what customers value in a product and how they evaluate the company and the competition are regular visits to customers, frequent contact by phone or email, participation in events with customers, and, even, customer satisfaction surveys.

Furthermore, the STBFs search for information about competitors, which helps them to compare their performance and competitor performance in relation to the CSFs. This information is also obtained from customers, common suppliers, internet, events, and several other activities from associations in the technology area. According to Fourcade (1991), the STBFs obtain a lot of information from the network of contacts they develop. Cebra even requests an evaluation of competitors in their satisfaction customer survey.

The second diagnosis activity is the environment analysis, which includes the regional environment, activity sector, and organization environment. In the region analysis, the important factors of a region for the success of the company should be determined and compared to the characteristics of the region in which the company is currently located and other potential locations. It was observed that the STBFs studied do not, in a structured form, perform a region analysis. They did not mention any specific technique for data collection or registering and analyzing data on this respect. Even so, they were able to list several factors when questioned about what is important in the environment of the company, probably by empirical analysis. The factors listed were personal (quality of life), human resources (cost of labor, qualification of labor and labor qualification capacity in the region), market (location of customers, suppliers, proximity to other technology companies, and formation of network of cooperation), fiscal/legal (tax benefits), infrastructure (restaurants, public transportation, banks and others), and political/institutional (good union relationships, easy access to governmental organizations).

The personal factors related to human resources match Santos and Pereira's (1989) report that one characteristic of STBFs is the employment of a highly qualified technical-scientific workforce. This implies a workforce that is very demanding in terms of the place to live and seeking a high quality of life. Moreover, there is a need for continuing professional development, which makes a region with a university and research center ideal. Also noteworthy is the need for participating in network of cooperation. The STBFs usually form a network, benefiting from the relationships developed with the companies that participate (Fourcade, 1991).

It was verified that the STBFs studied do not perform in a structured and detailed (deep) way the analysis of the sector of activity, or the comparison of the sector in which the company acts to other potential sectors. The interviewees did not list the use of any specific technique to collect, register, and analyze data in this respect. However, again, when questioned about their sector of activity, they were able to make an evaluation, probably by empirical analysis. This analysis is presented in Table 2.

Table 2 . ***Analysis of the Environment in the Sector of Activity***

Company	Buyer Power	Supplier Power	Competitive Rivalry	Threat of new entry	Threat of substitution	Government interference	Comple-mentors
Reason	High	Low	Medium	Low	Low	High	Low
Cebra	High	High	Medium	Medium	Medium	High	High
Reivax	High	Medium	Low	Low	Low	High	High
Cianet	Medium	Medium	Low	Low	Medium	High	High
Directa	High	Medium	Low	Medium	Low	High	High
Brasystem	Low	Low	Low	Medium	Medium	High	High

Source: Primary data, 2006.

As noted in Table 2, the power of buyers for five of the six companies is medium to high, since they are major customers in size, having more power in negotiations. Conversely, the power of suppliers is medium to low in five of the six STBFs, since the raw materials used are low in aggregated value and easy to substitute. The competition rivalry in all of the companies studied was evaluated as medium and low, probably due to the fact that the technologies are still new in the market, without many competitors. Due to the technological component of the products, the threat of new entry and substitution evaluated at 50 percent low and 50 percent medium, with none reporting high threats. The level of interference from the government was reported as high by 100 percent of the STBFs. For the *complementors*, or the importance of basic research development level in the sector, it was evaluated as high by 83 percent of the STBFs, mainly because the STBFs are heavily reliant on them to develop their technologies.

In terms of the analysis of the macro, operational and internal environment, it was observed that only few of them are performed by the STBFs. The macro and internal environments are not generally considered relevant, and, as a result, they do not gather any data about them. In relation to the macro-environment, the information considered important were the availability of credit lines, tax rates, and foreign exchange rates. However, the entrepreneurs seek only to be informed about them; they do not really use or work with these elements.

It is in the operational environment, mainly in relation to the competition and their products, technologies available and arising in the market, information on suppliers and customers that the STBFs researched informed they gather, register, and analyze a series of data. Cebra, Reivax, Cianet, and Directa demonstrated they have more structured forms, mainly related to gathering and registering information, than Reason and Brasystem because they have specialized software available and an area responsible for gathering the information. These four companies visit and phone customers, competition, suppliers, and governmental agencies; they participate in seminars, fairs, training sessions, associations of their sector of activity; they read specialized magazines; and they search websites. The data is filtered, and the information considered relevant is registered in specific software and analyzed in management meetings. In the end, strategies are elaborated in order to benefit from opportunities and minimize threats.

In finalizing the description of the environment analysis, it was noted that from the three activities -- region, sector of activity, and organization analysis -- few activities of the last are performed. The STBFs lack financial resources, impacting in the management of the company and forcing them to prioritize certain activities to the detriment of others they consider important. Though the network developed by the STBFs allows them to get information at a low cost, they tend to sub-utilize the information and, therefore, not develop environment analysis in a conscious and continuous way (Fourcade, 1991; Pearce II et. al., 1982; Gélinas, Bigras, 2004).

In relation to the field of activity, the evidence is that the STBFs analyzed seek whether or not the sector in which they operate is in accordance to the sector previously defined, just as the current strategy is compared to the direction of past strategies, in an effort to maintain synergy. There was no relevant evidence of the influence of the STBFs' characteristics on their process of formulation according to the model by Almeida (2003).

Conclusions and Recommendations

This research is aimed at identifying how the STBFs characteristics influence their strategy formulation process. To meet this objective, a qualitative approach research was performed, in a multi-case study involving six STBFs. We described and analyzed the process of strategy formulation of these firms based on the Almeida's (2003) strategy formulation model. The study conclusion summary is presented on table 3.

Table 3. ***Conclusion Summary***

Process of strategy formulation (Almeida, 2003)	**The Characteristics of the STBFs**
Orientation	
Superior Directives	STBFs studied do not follow superior directives because they are independent small units and are not attached to major corporate business. However, entrepreneur's technical expertise turns to be pivotal to the firm's field of operation and orientation.
Mission, Vision and Vocation	Founder's technical expertise shapes the mission, vision and the firms' vocation, driving their strategy formulation process. STBF products typically originate from the entrepreneur's technical expertise (technology push) more often than from an identified opportunity or from a market need (demand pull).
Diagnosis	
Internal Aspects	Critical Success Factors are identified, as traditionally, through close contact with costumers and evaluation of competitors.
Environment Analysis	Financial constraints restrict STBF from gathering direct competitor's information from planned surveys. STBFs researched get information almost exclusively from their network of contacts.
Field of Activity and current Strategy	No relevance.

Source: Research data, 2006.

Based on the analysis made in this study, we propose some recommendations for the development of a strategy formulation process for STBFs, useful to entrepreneurs, local government agents, and small business associations. For entrepreneurs, the preliminary identification of the technical background and vocation of each partner would better support the definition of the company's field of activity, mission and vision. This, then, should be the first step in the formulation strategy process at STBFs. Next, entrepreneurs should seek more to identifying market demands rather than trying to push developed technology to market. Technology push requires more investment in marketing information and its accurate analysis, a case limited by the restrictive financial condition typical to STBFs.

Third, by investing in the managerial capability of the top management, STBFs can broaden administrative and strategic views. STBF managers need to understand the importance of balancing technical knowledge with managing employees. Fourth, a consultant should be hired to help in the process of strategy formulation if the entrepreneur lacks experience with strategy formulation. Fifth, investing in information systems can strongly help entrepreneurs to make better environment analyses.

For local government agents and Small Business Associations, we recommend they first focus on marketing research and other tools to provide information about the market for the STBFs in specific sectors of the economy. Next, due to the importance of networking and data gathering for STBFs, their main resource of environment information, Small Business Associations, can help by supporting STBFs to build their network contacts through illustrative round tables and conferences to entrepreneurs. Third, Small Business Associations should support increasing the entrepreneurs' strategic knowledge by offering specific training. Another effective action is to hire consultants in enterprise strategy and make them available to STBFs. Last, help STBFs find cost effective solutions to improve their information systems through training, consulting, and specific orientations in this area.

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